Ethological Studies on

Funambulus pennantii pennantii

in Urban and Semi-Urban Areas of Agra

SYNOPSIS

Submitted for the registration

Of

The Degree of Doctor of Philosophy

In

ZOOLOGY

Submitted by:

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1. INTRODUCTION

Funambulus pennantii pennantii (Wroughton, 1905) is commonly known as the Northern palm squirrel or five striped squirrel. It is one of the most common rodents found across India. According to the IUCN status, it is listed under the **Least Concern (LC)** category.

Plate 1 Funambulus pennantii pennantii

Classification :

Kingdom- Animalia

Phylum- Chordata

Order- Rodentia

Family- Sciuridae

Genus- ***Funambulus***

Species- ***pennantii***

` **Sub species-** ***pennantii*** **(Plate 1)**

Squirrels of the world are categorised according to their mode of life, viz. – Flying squirrels, Ground squirrels and Tree squirrels. They differ in their morphology and ecology and seem to have evolved different social structures and behaviors **(Nandini, 2011).** *Funambulus p. pennantii* is diurnal, semi arboreal, thriving in Nepal, India and Bangladesh and inhabits open plains, scrub lands, frequently found in vicinity of villages. Adults are omnivores, feed on honey from unprotective beehives and insects like termites and caterpillars. They build globular nest around buildings, under tiles and caves, tree branches and palm leaves. Generally, breeding season remains throughout the year, peaking in March-April and July- August. Courtship involves mating chase, mating calls and grooming for one day. According to Hindu mythology, squirrels are considered to be sacred. Indian palm squirrels have been recommended as an excellent model for studying social abilities **(Rajaratnam and Redman, 1998).**

Ethology is the study of behavior and activity patterns of animals in their natural habitat. In applied ethology, there has been considerable interest in the development of methods and technologies that allows reliable quantification of behavior **(Watts and Stookey, 1999).** The various activity patterns of an animal are not static and change with the environmental fluctuations for example, availablitiy of food **(Kuo and Lee, 2012)** and thus they attempt to cope up with these environmental changes which results in different behavioral responses.

2011-2015 have been the hottest years of the last hundred years and this has resulted in climate change across the globe. The species may have also undergone changes in terms of behavior and trends in population, especially in view of changes in habitat. The present work is an attempt to study the behavior of *Funambulus p. pennantii* at different areas in Agra (urban and semi urban), their interaction with other species including humans and assessing their cognitive abilities in context of food assessment and caching abilities.

2. REVIEW OF LITERATURE

2.1 International status

Wade (1927) observed the breeding habits and early life of the thirteen striped ground squirrel. Steiner (1969) studied play behavior in Columbian ground squirrels. Leger *et al.* (1983) determined the behavior of California ground squirrels and also attempted to discover the size of habitat area. Borges (1993) discussed the importance of figs as a resource for giant squirrels during shortage of food. Thorington and Darrow (1996) studied the jaw, supra hyoid and tongue muscles in Old World squirrels. Chang *et al*. (2011) studied the hybridization and underestimated species diversity in Asian striped squirrels. Thorington *et al.* (2012) described about the squirrels of the world. Kuo and Lee (2012) assessed the home range and behavioral responses to fluctuations in food quality, rainfall and temperature in flying giant squirrel species. Samson and Manser (2015) demonstrated caching abilities of Cape ground squirrels in presence of audience.

2.2 National status

Prasad (1957) compared the male genital tracts of the Indian and Ceylonese palm squirrels. Prakash (1960) studied breeding habits in different types of mammals including *F. pennantii*. Dhaliwal and Prasad (1965) described the cytology and cytochemistry of pituitary gland during different phases of reproductive cycle in *Funambulus pennantii*. Seth and Prasad (1969) evaluated the reproductive cycle of the five striped Indian palm squirrel. Datta (1998) observed the anti-predatory response of giant squirrels to predation attempts by the crested hawk eagle. Rajaratnam and Redman (1999) found social cues from conspecifics to help synchronize free running activity rhythms in diurnal five striped palm squirrels. Srinivas *et al.* (2008) presented the site occupancy in an unstudied population of Indian giant squirrel, *Ratufa indica* in Tamil Nadu. Kanoje (2008) evaluated the feeding and nesting behavior of giant squirrels in Central India. Sushma and Singh (2008) reported an incident of predation on giant squirrel by lion tailed macaque. Mammen and Jagota (2010) studied the daily locomotor activity rhythms to confirm diurnality in *Funambulus*

pennantii. Kour *et al.* (2014) studied the seasonal behavioral patterns of *F. pennantii*. Rao *et al.* (2015) studied the activity patterns and food habits of grizzled giant squirrel.

2.3 Need of the study

Review of literature reveals that work has been done on giant squirrels in India but there are no holistic reports on complete ethology of five striped palm squirrel, *F. pennantii*. Since it is the most successfully thriving diurnal mammalian species besides humans in cosmopolitan set ups, despite the hottest four year patch from 2011-2015, insights into its behavior and cognition will prove to be vital in its continued conservation and welfare and thus it can be regarded as an ecological indicator species. Therefore, the present study has been designed to elucidate the activity patterns, inter-specific interactions, seasonal behavioral variations and cognitive abilities of *F. p. pennantii* in terms of food assessment and caching abilities at urban v/s semi urban areas.

3. OBJECTIVES

i). To study the activity patterns of *F. p. pennantii* inhabiting urban and semi urban areas of Agra .

ii). To assess the cognitive abilities in terms of food assessment and caching ability in *F. p. pennantii* inhabiting urban and semi urban areas of Agra.

iii). To observe the inter-specific interactions of *F. p. pennantii* inhabiting urban and semi urban areas of Agra.

iv). To compare and analyse seasonal variations in behavior of *F. p. pennantii* inhabiting urban and semi urban areas of Agra.

4. HYPOTHESIS

The following null hypothesis has been formulated for the present study:

H_0 = There is no significant difference in the activity patterns, cognitive abilities, inter specific interactions and seasonal variations in the behavior of *Funambulus pennantii pennantii* in urban and semi urban areas of Agra.

The following alternate hypothesis has been formulated for the present study:

H_a = There is significant difference in the activity patterns, cognitive abilities, inter specific interactions and seasonal variations in the behavior of *Funambulus pennantii pennantii* in urban and semi urban areas of Agra.

5. METHODOLOGY

Since it is a non-invasive study, it does not require any ethical approval

5.1. Sampling sites

Maps showing the selected sampling sites are depicted in Fig.1,2,3and 4

Following semi urban areas have been selected for the study:

1. Dayalbagh
2. Shahjahan Gardens

Following urban areas have been selected for the study:

3. Balkeshwar
4. Sikandra

According to UNICEF, definitions are as follows

Semi urban areas: They are surrounding residential areas around cities with the population less than 5000 and has agricultural land.

Urban areas: An area of population size of 5000 or more who are not primarily engaged in agriculture and majority of area is constructed area.

Semi-Urban areas are satellite areas situated near main city (Urban) areas.

Selection of sites is on the basis of good number of preliminary citings of *F. p. pennantii* and also ease of negotiation, approach and safety of observer.

5.2 Behavioral sampling techniques

Following sampling techniques will be used:

1. Focal sampling technique (Martin & Bateson 1995)
2. Scan sampling technique (Altmann, 1974)
3. *Ad-libitum* sampling (Altmann 1974)

Activities of each subject will be observed and recorded on the respective data sheets. Each activity will be assigned a particular code to make the recording of data convenient. Each field observation of an hour will be divided into four sampling periods of 15 min. each (Observation period of 10 min. with 5 min. interval to prepare for next observation period).

5.3 Sample size

There is no information on population trends at different sites, therefore the sample size cannot be predetermined. Moreover, since there is no difference in the appearance of individuals of a population, we will look for subtle differences in body size, tail size and head-rostrum area.

5.4 Observation schedule

Observations will be taken throughout the year across 5 different seasons – Spring (Feb-March), Summer (April-June), Monsoon (July-Sept.), Autumn (Oct-Nov) and Winter(Dec-Jan).

Since it is a diurnal species, observations will be conducted from sunrise to sunset in the following slots.

1. 7am – 9am – spring, summer, monsoon, autumn
2. 9am-11am – all seasons
3. 11am-1pm – spring, winter, autumn
4. 1pm-3pm – spring, winter, autumn
5. 3pm-5pm- spring, winter, autumn
6. 5pm-7pm – spring, summer, autumn

5.5 Tools and equipment

1. 24x optical zoom camera for still photography and videography
2. Note pad
3. Stopwatch
4. Bio acoustic recording device and analysis software (MAT LAB)
5. Behavior coding software (Observer^{XT} student free trial pack)
6. Binoculars

5.6 Sampling method

Random sampling will be employed because *F. pennantii* is a very active and swift species. A particular individual's presence at a particular place and time is difficult to predict.

Probability sampling

↓

Random sampling

↓

Interval sampling

Maps showing selected urban and semi urban areas of Agra

Fig. 1

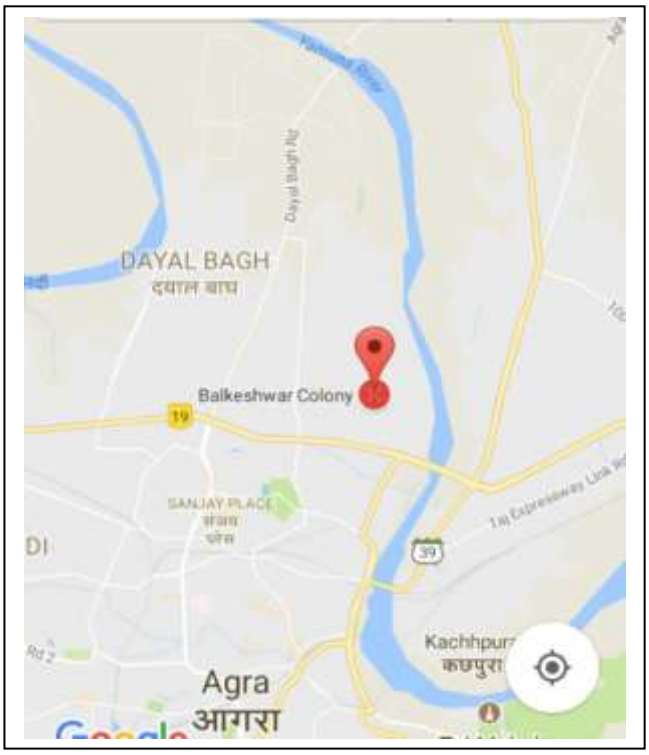


Fig. 3

Fig. 2

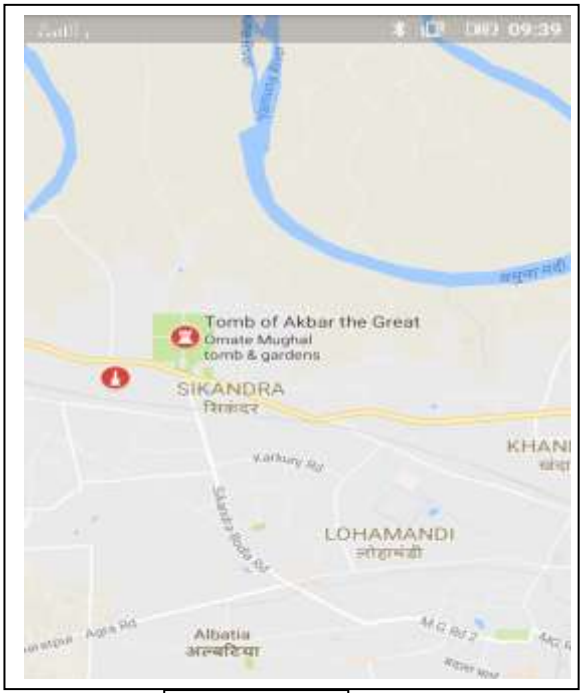
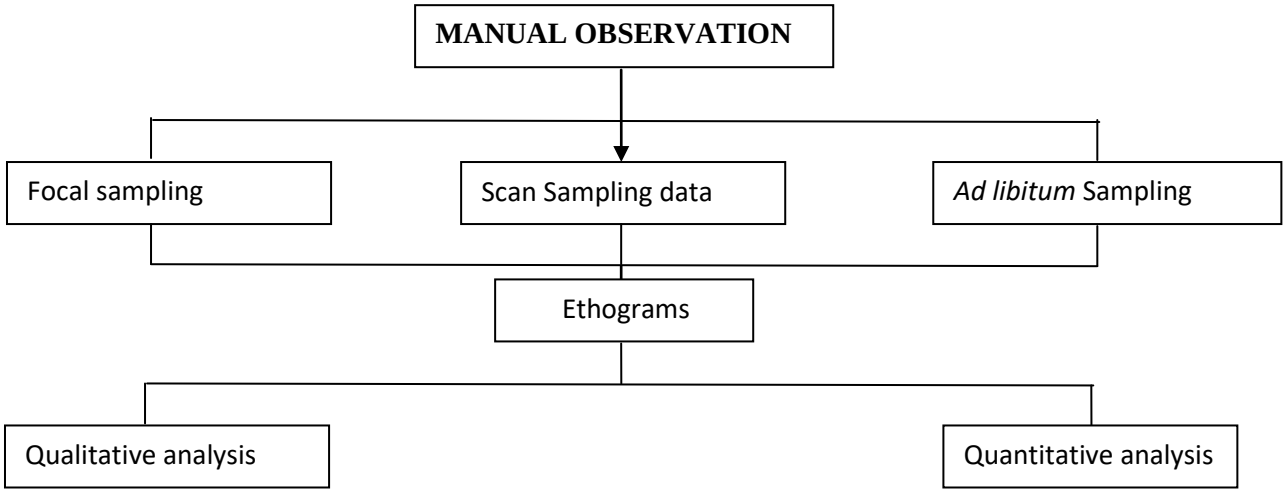


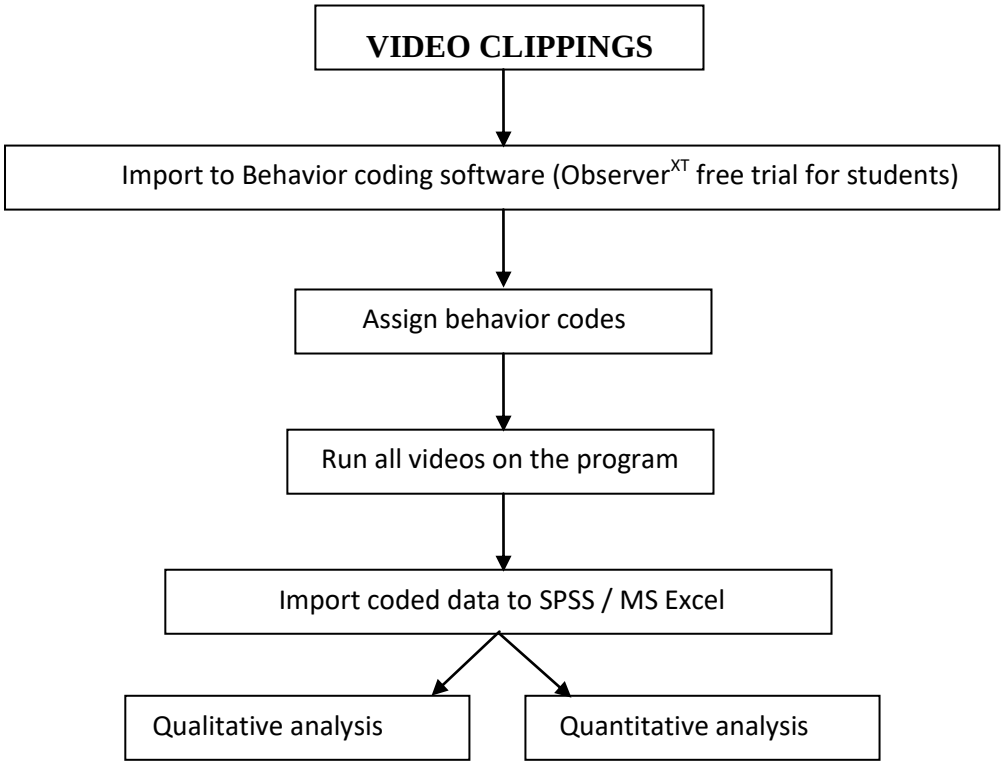
Fig. 4

DESIGN OF RESEARCH

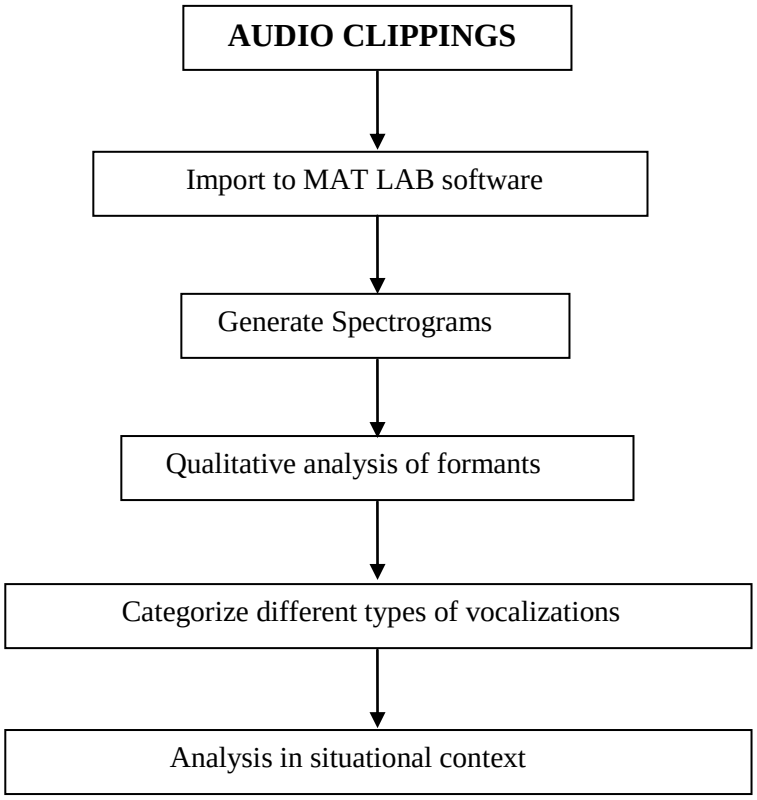
a). MANUAL OBSERVATION



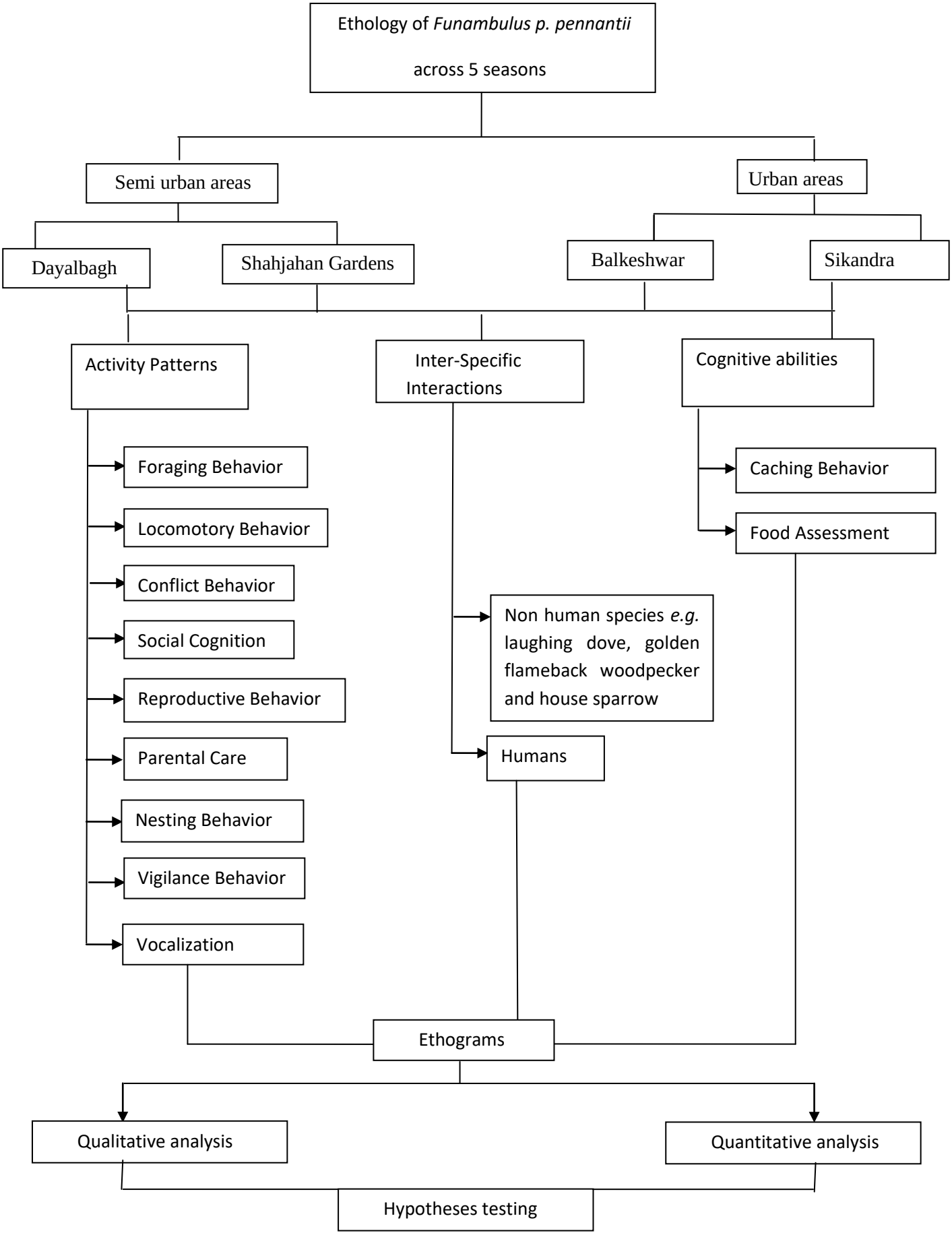
b). VIDEO CLIPPINGS


VIDEO CLIPPINGS
Import to Behavior coding software (Observer^{XT} free trial for students)
Assign behavior codes
Run all videos on the program
Import coded data to SPSS / MS Excel
Qualitative analysis
Quantitative analysis

C). AUDIO CLIPPINGS



PLAN OF WORK


Ethology of *Funambulus p. pennantii* across 5 seasons
Semi urban areas
Urban areas
Dayalbagh
Shahjahan Gardens
Balkeshwar
Sikandra
Activity Patterns
Inter-Specific Interactions
Cognitive abilities
Foraging Behavior
Locomotory Behavior
Conflict Behavior
Social Cognition
Reproductive Behavior
Parental Care
Nesting Behavior
Vigilance Behavior
Vocalization
Non human species *e.g.* laughing dove, golden flameback woodpecker and house sparrow
Humans
Caching Behavior
Food Assessment
Ethograms
Qualitative analysis
Quantitative analysis
Hypotheses testing

REFERENCES

1. Altmann, J. (1974). Observational study of behavior: sampling methods. *Behavior*, 49(3): 227-266.
2. Borges, R. M. (1993). Figs, Malabar giant squirrels, and fruit shortages within two tropical Indian forests. *Biotropica*, 183-190.
3. Chang, S. W., Oshida, T., Endo, H., Nguyen, S. T., Dang, C. N., Nguyen, D. X., & Lin, L. K. (2011). Ancient hybridization and underestimated species diversity in Asian striped squirrels (genus *Tamiops)*: inference from paternal, maternal and biparental markers. *Journal of Zoology*, 285(2): 128-138.
4. Datta, A. (1998). Anti-predatory response of the Indian giant squirrel *Ratufa indica* to predation attempts by the Crested Hawk Eagle *Spizaetus cirrhatus limnaetus*. *J. Bombay Nat. Hist. Soc*, 95: 332-335.
5. Nandini, R. (2011) *sciurids* : 1-61.
6. Dhaliwal, G. K., & Prasad, M. R. N. (1965). Cytology and histochemistry of the pituitary gland of the five striped palm squirrel, *Funambulus pennantii* (Wroughton). *Developmental Dynamics*, 117(3): 339-351.
7. Kanoje, R. S. (2008). Nesting sites of Indian giant squirrels in Sitanadi Wildlife Sanctuary, India. *Current Science*, 882-884.
8. Kour, D. N., Sahi, D. N., & Sharma, R. (2014). Sex related Seasonal Patterns of Time and Activity Allocation in the Northern Five Striped Palm Squirrel, *Funambulus pennanti* in Jammu (Jammu and Kashmir), India. *Int. J. Curr. Microbiol. App. Sci*, 3(1), 309-314.
9. Kuo, C. C., & Lee, L. L. (2012). Home range and activity of the Indian giant flying squirrel *(Petaurista philippensis*) in Taiwan: influence of diet, temperature, and rainfall. *Acta Theriologica*, 57(3): 269-276.
10. Leger, D. W., Owings, D. H., & Coss, R. G. (1983). Behavioral ecology of time allocation in California ground squirrels *(Spermophilus beecheyi*): Microhabitat effects. *Journal of Comparative Psychology*, 97(4): 283.

11. Mammen, A. P., & Jagota, A. (2010). Immunocytochemical evidence for different patterns in daily rhythms of VIP and AVP peptides in the suprachiasmatic nucleus of diurnal *Funambulus pennantii*. *Brain Research*,1373: 39-47.
12. Prakash, I. (1960). Breeding of mammals in Rajasthan desert, India. *Journal of Mammalogy,* 41(3): 386-389.
13. Prasad, M. R. N. (1957). Male genital tract of the Indian and Ceylonese palm squirrels and its bearing on the systematics of the Sciuridae. *Acta Zoologica*, 38(1): 1-26.
14. Rajaratnam, S. M., & Redman, J. R. (1999). Social contact synchronizes free-running activity rhythms of diurnal palm squirrels. *Physiology & Behavior*, 66(1): 21-26.
15. Rao, G. S., Nagarajan, R., Saravanan, M., & Baskaran, N. (2015). Activity pattern and food habits of Grizzled Giant Squirrel *(Ratufa macroura*) in Srivilliputhur Grizzled Squirrel Wildlife Sanctuary, Tamil Nadu, Southern India. *International Letters of Natural Sciences*, 54-67.
16. Samson, J. and Manser, M.B. (2015). Caching in the presence of competitors: Are cape ground squirrels (*Xerus inauris*) sensitive to audience attentiveness?. *Animal Cognition*, 19(1): 31-38.
17. Seth, P., & Prasad, M. R. N. (1969). Reproductive cycle of the female five-striped Indian palm squirrel, *Funambulus pennantii* (Wroughton). *Journal of Reproduction and Fertility*, 20(2): 211-222.
18. Srinivas, V., Venugopal, P. D., & Ram, S. (2008). Site occupancy of the Indian giant squirrel *Ratufa indica* (Erxleben) in Kalakad–Mundanthurai Tiger Reserve, Tamil Nadu, India. *Current Science*: 889-894.
19. Steiner, A. L. (1969). Play activity of Columbian ground squirrels. *Ethology*,28(3): 247-261.
20. Sushma, H. S., & Singh, M. (2008). Hunting of Indian giant squirrel *(Ratufa indica*) by the lion-tailed macaque (*Macaca silenus)* in the Western Ghats, India. *Current Science*, 95(11): 1535-1536.

21. Thorington, R. K., & Darrow, K. (1996). Jaw muscles of Old World squirrels. *Journal of Morphology,* 230(2): 145-165.

22. Thorington Jr, R. W., Koprowski, J. L., Steele, M. A., & Whatton, J. F. (2012). *Squirrels of the world.* JHU Press.

23. Wade, O. (1927). Breeding habits and early life of the thirteen-striped ground squirrel, *Citellus tridecemlineatus* (Mitchill). *Journal of Mammalogy*, 8(4): 269-276.

24. Watts, J. M. and Stookey, J. M. (1999). Vocal behaviour in cattle: the animal's commentary on its biological processes and welfare. *Applied Animal Behavior*,67 : 15-33.

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